burner motor and other moving parts must be properly designed to operate continuously throughout the heating season.

Graduated Continuous Flame: In this type of burner, the operation is continuous as with the high-low type with high and low limits of combustion rate to satisfy the greatest and least demands for heat. However, the burner is arranged to operate at several intermediate steps instead of at only two points, so that the rate of combustion is proportioned more nearly to the demand for heat. With manual operation, the oil and air may be separately adjusted to any required rate of combustion, but for automatic operation, the oil and air controls must be interlocking and must be capable of permanent separate adjustment at the several intermediate steps. With mechanical draft, the burner motor and other moving parts must be designed for continuous service.

Relative Merits: Engineers are not in agreement concerning the relative merits of the three methods of operation from the standpoint of fuel consumption. The high-low or graduated systems may have a slight advantage during the coldest weather, whereas, the intermittent burner will usually be more economical during the milder weather. Over the entire heating season, the total amount of fuel used usually will be very nearly the same.

Types of Burners

There are two distinct types of oil burners used for oil heating—the natural draft burner and the mechanical draft burner. Their names indicate the manner in which the air for combustion is obtained.

Natural Draft Burners: The natural draft burner requires no motor and usually has no moving parts. The air for combustion is supplied by the pull of the chimney and is, therefore, dependent upon the construction of the latter. This type of burner is often incorrectly referred to as a *gravity* type burner. Gravity indicates the manner in which the fuel is fed to the burner and a gravity system is applicable to either natural draft or mechanical draft burners. This type of burner is more susceptible to changes in the weather, wind currents about the chimney and other factors which cause a variation in the draft intensity than is the mechanical draft burner, unless the effects of this variation in draft can be overcome in the design of the chimney, in the design of the burner, or by the use of a draft regulator. A natural draft burner usually is limited to small heating loads, depending in size somewhat on the design of burner, and for best operation requires the use of lighter oils. It has in its favor a low first cost, simplicity of design, and requires no power for operation.

Mechanical Draft Burners: The mechanical draft burner is motor-driven and often the air for combustion is supplied by a fan or blower. Generally, where a fan is used it is of sufficient capacity to supply the entire amount of air for combustion when the burner is operating at its maximum capacity. Often where a blower, either of a centrifugal or positive pressure-type is used, only a portion of the air required is supplied under pressure, the balance being induced by the injector action of the air from the blower, plus the natural draft from the chimney. The air from the blower usually is used to aid in the atomization of the fuel. The blower produces a comparatively constant supply of air under varying

draft conditions, and therefore, maintains a uniformly efficient combustion condition.

Another classification of burners used has to do with the means employed to prepare the fuel for combustion. The terms are vaporizing and atomizing burners.

Vaporizing Burners: In the vaporizing burner the fuel is prepared for combustion by the addition of heat. The heat serves to convert the liquid fuel into a vapor which is mixed with the air for combustion either just before or during the combustion process. Blue flame combustion is sometimes advocated, but as a blue flame radiates very little heat it is of no particular advantage in a boiler or furnace that has been designed for coal burning, wherein the major heat transfer is secured through radiation. By vaporizing the fuel, moving parts can be eliminated and the fire is easy to control at low combustion rates. However, vaporizing burners require a light fuel for best results and with poor design there is the possibility of carbon trouble due to cracking or decomposition of the oil in the vaporizing chamber.

Atomizing Burners: In the atomizing burner the fuel is broken into a fine mist which is mixed with the air for combustion either just before or progressively during the combustion process. The particles are so fine that they are quickly vaporized by the heat of combustion and if properly mixed with sufficient air will burn with a clean hot flame. There are many ways to atomize oil—under pressure through a small orifice, by compressed air or steam, by centrifugal force from the edge of a rapidly rotating cup or disc and by numerous other equally effective methods. Any of the methods used will break the oil into very fine particles and when applied with intelligence will give satisfactory results. With the atomizing type of burner cheaper oils may be utilized than with other types of burners; they will start readily from a cold condition and can be applied to installations requiring a high fuel consumption.

Systems of Ignition

The methods of ignition may be classified as follows:

1. Manual.
2. Continuous gas pilot.
3. Expanding gas pilot.
4. Continuous electric spark.
5. Intermittent spark.
6. Combination electric spark and gas.

Ignition of the high-low and graduated continuous flame burners is *manual,* by means of a gas or oil torch. No automatic ignition devices are required. If the oil is prepared for combustion by vaporization, sufficient time is required to preheat the vaporizing plate or chamber. If the oil is atomized, preheating is unnecessary.

In most natural draft burners the oil is lighted manually with a torch through the fire door, although some of them are provided with gas, electric or oil pilot, at the option of the owner.

The *continuous gas pilot* method of ignition is simple, but to insure an adequate flame in case the pressure drops, an excessively large flame must be used, consuming an excessive amount of gas.